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# Emergency surgery for obstructing or perforated colon cancer; rate of re-intervention and prognostic factors: A single center study

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## ABSTRACT

*Aim:* Emergency complications of colon cancer including obstruction and perforation can be seen in up to one third of patients as an initial presentation. The aim of this study is to determine the rate of re-intervention, incidence of complications, and prognostic factors of emergency surgery in obstructing and perforated colon cancer. *Methods:* Data of patients with colorectal cancer managed in our hospital during a 5-year period were retrospectively analyzed. Only patients presented to the emergency department (ED) for a complicated colorectal cancer with obstruction or perforation and underwent a surgical intervention were included. *Results:* A total of 176 colon cancer patients with a mean age of 64.24 were included. Obstructing colon cancer was the most commonly presented complication (70%), followed by perforated colon cancer (17.5%). Around 42% were diagnosed prior to ED visit and 58%were diagnosed first in the ED at the time of complication. Fifty-two (30.6%) patients underwent a surgical re-intervention. In the univariate analysis, hospitalization duration and undergoing a surgical re-intervention were the most significant factors associated with post-operative complications (p=0.002). Additionally, patients who underwent laparotomy had almost 3 times higher risk for experiencing post-operative complications compared to those who underwent a laparoscopic approach, OR= 2.801, p=.018; (CI 95% 1.195-6.568). The mortality incidence is 13.5%. *Conclusion:* Rate of re-intervention appears to be high and associated with increased mortality among patients with complicated colon cancer. Further studies are needed to determine the appropriate timing and indication for undergoing a surgical intervention after initial surgical management for complicated colon cancer.

**Keywords:** CRC; obstruction; perforation; emergency; reintervention.

## 1. INTRODUCTION

Colorectal cancer (CRC) has been considered to be the most common type of cancer among men and the third most commonest type of cancer among women in Saudi Arabia (Alsanea et al., 2015). Emergency complications of colon cancer including obstruction and perforation can be seen in up to one third of patients as an initial presentation. Colon cancer with obstruction constitutes 8-40% of colon cancer first presentation, and 3-10% of cases present with bowel perforation (Biondo et al., 2005). These complications have been associated with worse prognostic outcomes in patients undergoing emergency surgery compared to those undergoing elective surgery with 12-32% 5 year-survival rate and a higher rates of cancer recurrence (Ho et al., 2010; McArdle et al., 2004). Therefore, even though emergent surgical interventions tend to be of a high risk, the importance of performing curative surgery is not the same as in elective curative surgeries. Several studies reported the outcomes of those who underwent emergent surgeries for complicated colon cancer. In 2017, a study was done to compare the outcome of colon cancer patients who initially presented as colonic obstruction versus those with colon perforation. Those with perforation had poorer progression-free survival, a higher rate of local recurrence, and a higher rate of distant metastasis. However, there were no differences in the overall survival between the two groups (Chen et al., 2017).

More recently, a study assessed the prognostic factors and patterns of recurrence after emergency management for obstructing colon cancer. Several factors such as older age (>75), right sided colon cancer, and ASA score (≥ 3) were associated with poor prognosis. The study concluded that other patient-dependent factors should be taken into account in the management of obstructing colon cancer (Manceau et al., 2019). In one study, it was noted that the presence of positive lymph nodes, anastomotic dehiscence, diffuse peritonitis, and male gender were independent predictors for poor prognosis (Biondo et al., 2019). Emergent surgical interventions in colon cancer is associated with high postoperative morbidity and mortality rates as well as lengthy hospital stay in comparison to elective surgical interventions (de' Angelis et al., 2019; Sjo et al., 2009).

Surgical site infection, anastomotic leakage and postoperative peritonitis are the most common noted surgical complications seen after colorectal cancer resection (de' Angelis et al., 2019). Another study was done in Poland and Italy on emergent right hemi-colectomy complications, their results showed postoperative morbidity rate to be 28.1% while the mortality rate was 12.1%. It was noted that 25% of patients presented with perforation and diffuse peritonitis had the highest mortality rate. Other observed complications were surgical site infection (25%), wound dehiscence (25%), pulmonary edema (12.5%) and intra-abdominal abscess (12.5%), (Tabola et al., 2017). Postoperative adverse effects and long-term outcomes have been associated more with emergent surgical interventions (Shah et al., 2012).

The choice of the operative approach in the emergency treatment of complicated colorectal cancer depends on several factors including the tumor location, the well-state of the patient, and the overall staging of the tumor. Primary resection with anastomosis and Hartmann's procedure are not competing operations, but two situation-dependent therapeutic alternatives that should be used according to the clinical situation (Charbonnet et al., 2008; Ramos et al., 2017; Kube et al., 2010). Multiple studies reported the outcomes of patients undergoing surgical management of colon cancer; however, there are limited numbers of data concerning patients with bowel obstruction or perforation secondary to colon cancer. Furthermore, other variables such as rate of re-intervention and its affect on the overall survival are not fully explored.

Our study permits a preliminary assessment of the clinical course and outcomes of patients presenting with complicated colon cancer and underwent a surgical intervention. Finally, we hope that our findings presented here will encourage more extensive studies to investigate the interventions that can improve the outcomes of colon cancer patients.

## 2. MATERIALS AND METHODS

**Ethical consideration and study settings**

This study complies with the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of King Abdullah International Medical Research Center (KAIMRC) (RC 20/518/R), IRBC/1827/20, and waived the need for informed consent from individual patients owing to the retrospective nature of the study. The study was conducted at King Abdulaziz Medical City, Riyadh, Saudi Arabia.

**Study design and data collection**

For this single center retrospective study, we recruited adult patients diagnosed with colorectal cancer from Jan 1 2015 to Jan 1 2020. Data was acquired by searching the electronic medical database of the Riyadh National Guard Health Affairs for inpatient and outpatient hospital visits including emergency department visits accompanied with a diagnosis code for colon/rectal cancer. A total of 1184 patients were diagnosed with colon cancer in our institution during this period. The electronic medical records of the

persons were then carefully manually reviewed to ensure that patients with colonic obstruction or perforation requiring surgical intervention were included. Clearance was done to exclude patients who do not fulfill our inclusion criteria. After excluding the duplicate data, and those with incomplete data, the sample size which met our inclusion criteria was found to be 176 patients.

**Study variables**

The study variables were collected and organized into 4 main sections: (1) patients' characteristics including demographical data and the presence of comorbidities; (2) tumor characteristics such as the time of diagnosis, location of the tumor, received treatment, and the type of complication (obstruction or perforation); (3) surgery characteristics which include the surgical approach, type of surgeon performing the surgery, and rate of re-intervention; (4) patients' outcomes consisting of post-operative destination, post-operative complications; and final outcome (discharged versus passed away).

**Statistical analysis**

Data was entered and analyzed using (SPSS) version 25. A p-value < 0.05 and 95% CI was used to report the significance. For descriptive statistical analysis, numerical variables were presented as means and standard deviations while categorical variables were displayed as frequencies and proportions. For the dichotomous dependent variables Final outcome, Re-intervention, Post-op complication and Type of complication, binary logistic regression was inferred. In addition for the continuous dependent variable Hospitalization Duration, general linear model was employed to assess potential risk factors. Furthermore, to control for confounders, multivariate analysis was used for adjustment.

## 3. RESULTS

A total of 176 colon cancer patients aged between 26 and 90 were included in this analysis. The mean age was 64.24 and majority of patients were males 102 (57.6%) vs 75 females (42.4%). Diabetes mellitus was the most common co-morbid disease presenting in about half of the study population (51.1%), followed by hypertension (47.1%). Inflammatory bowel disease was the least common illness, only 2 patients (1.1%) had a history of inflammatory ulcerative colitis disease. No history of crohn's disease was detected in the study sample. Most patients had a normal BMI (35.6%) and nearly 30% were overweight and obese. Regarding patients ED diagnosis and admission, (42.4%) were diagnosed prior to ED visit and (57%) were diagnosed first in the ED at the time of complication. Most patients did not receive any treatment in the pre-emergency admission (76%) vs (24.1%). Among those who were diagnosed prior to ED visit and received treatment, chemotherapy with 2 agents was the most commonly received treatment (43.6%). The tumor was localized in sigmoid in nearly (40%) of the patients. Furthermore, around (60%) of the patients underwent laparotomy and (41.5%) laparoscopy. Most of these surgeries were performed by colorectal surgeons (84.6%) and around (15.4%) were performed by general surgeons. In addition, 50 patients (29.8%) experienced post-op complications and 52 (30.6%) required a surgical re-intervention. The mean duration between patient admission and surgery was 97.88 hours and the mean hospitalization stay was 14.5 days with minimum stay being only one day and maximum is 76 days. Most patients who underwent the surgery were discharged 148 (86.5%) while 23 patients (13.5%) passed away (Table 1).

**Table 1** Descriptive statistics of patient and tumor characteristics

| | | | Frequency (n) / Mean | Percent (%) / SD |
|---|---|---|---|---|
| Age in years | *Min.*<br>26 | *Max.*<br>90 | 64.24 | 12.549 |
| Duration between presentation and surgery (Hours) | *Min.*<br>3 | *Max*<br>1344 | 97.88 | 150.646 |
| Hospitalization duration (day) | *Min.*<br>1 | *Max*<br>76 | 14.50 | 11.303 |
| Gender | Female<br>Male | | 75<br>102 | 42.4<br>57.6 |
| Comorbidities | History of inflammatory bowel disease (UC) | | 2 | 1.1 |
| | History of Cardiovascular disease (CVD) | | 35 | 20.1 |

| | | | |
|---|---|---|---|
| | History of Cerebrovascular accident (CVA) | 7 | 4.0 |
| | History of pulmonary disease | 23 | 13.2 |
| | History of hypertension | 82 | 47.1 |
| | History of diabetes mellitus | 89 | 51.1 |
| | History of liver disease | 8 | 4.6 |
| | History of renal impairment | 13 | 7.5 |
| | History of other malignancy | 12 | 6.9 |
| | BMI (Overweight) | 50 | 29 |
| | BMI (Obese) | 52 | 29.5 |
| Pre emergency department diagnosis of CRC | No | 95 | 57.6 |
| | Yes | 70 | 42.4 |
| Pre emergency department duration of CRC | No (was not diagnosed) | 95 | 57.9 |
| | Yes, in the previous 3 months | 22 | 13.4 |
| | Yes, in the previous 6 months | 7 | 4.3 |
| | Yes, in previous 12 months OR more | 20 | 12.2 |
| | Yes, but unknown | 20 | 12.2 |
| Pre emergency department CRC stage T | T x | 92 | 59.4 |
| | T is/1 | 2 | 1.3 |
| | T 2 | 2 | 1.3 |
| | T 3 | 10 | 6.5 |
| | T 4 | 10 | 6.5 |
| | Unknown | 39 | 25.2 |
| Lymph node (N) | N x | 95 | 60.9 |
| | N 0 | 6 | 3.8 |
| | N 1a/1b | 10 | 6.4 |
| | N2 | 5 | 3.2 |
| | N3+ | 1 | .6 |
| | Unknown | 39 | 25.0 |
| Metastasis | M x | 107 | 71.8 |
| | M 0 | 9 | 6.0 |
| | M 1 | 15 | 10.1 |
| | Unknown | 18 | 12.1 |
| Pre- ED CRC treatment | Not treated | 123 | 75.9 |
| | Treated | 39 | 24.1 |
| Type of Pre- ED CRC treatment | Surgery | 5 | 12.8 |
| | Chemotherapy 1 agent | 6 | 15.4 |
| | Chemotherapy 2 agents | 17 | 43.6 |
| | Radiation | 1 | 2.6 |
| | Combination of treatment methods | 10 | 25.6 |
| ED first diagnosis of CRC at time of complication | No | 71 | 43.0 |
| | Yes, first presentation at ED | 94 | 57.0 |
| Tumor-Location | Ascending | 16 | 10.5 |
| | Descending | 21 | 13.7 |

| | | | |
|---|---|---|---|
| | Transverse | 18 | 11.8 |
| | Sigmoid | 61 | 39.9 |
| | Rectum | 21 | 13.7 |
| | Cecum | 16 | 10.5 |
| Type of surgical procedure | Laparotomy | 100 | 58.5 |
| | Laparoscopy | 71 | 41.5 |
| Type of surgeon | Colorectal surgeon | 143 | 84.6 |
| | General surgeon | 26 | 15.4 |
| Post-op destination | Surgical ward | 122 | 73.5 |
| | ICU | 44 | 26.5 |
| Recurrence of obstruction or perforation | No | 145 | 85.8 |
| | Yes | 24 | 14.2 |
| Post-op complication | No | 118 | 70.2 |
| | Yes | 50 | 29.8 |
| Type of post-op complication | Bleeding<br>Cardiopulmonary<br>Venous thromboembolic event<br>Sepsis<br>Other | 6<br>11<br>6<br>10<br>17 | 3.6<br>6.5<br>3.6<br>6.0<br>10.1 |
| Re-intervention | No | 118 | 69.4 |
| | Yes | 52 | 30.6 |
| Final outcome | Discharged | 148 | 86.5 |
| | Passed away | 23 | 13.5 |

Most patients who underwent a re-intervention were for a curative approach 43% and only 20% required a re-intervention due to surgical complication (Figure 1). Obstructing colon cancer was the most commonly presented complication accounting for about (70%) of admissions, followed by perforated colon cancer (17.5%). Perforated rectal cancer was the least common complication in the sample accounting for less than 10% (Figure 2).

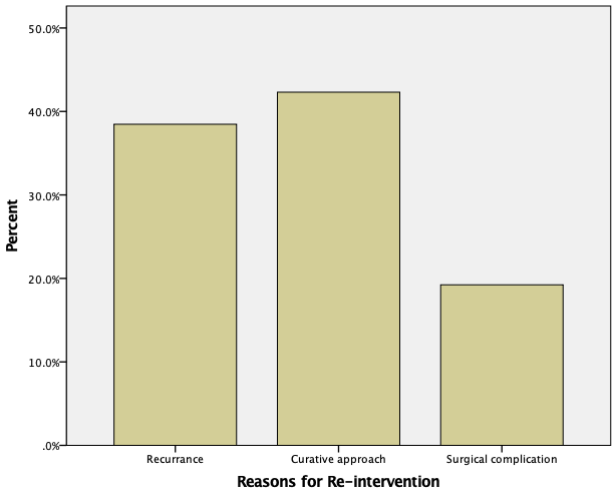


**Figure 1** Reasons for re-intervention

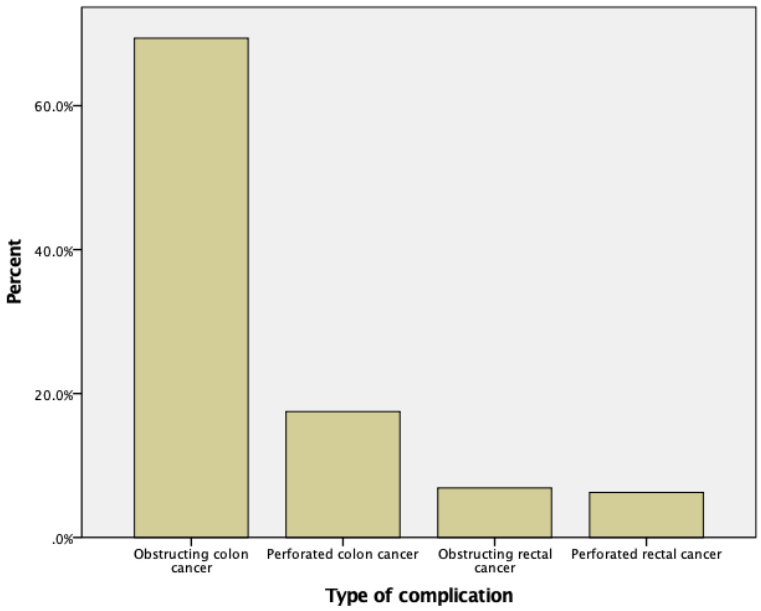


**Figure 2** Type of complication

In the logistic regression table (Table 2) age was a significant predeterminant for undergoing surgical re-intervention. For each year increase in age, the likelihood of reintervention decreases by 3.3%, OR=.967, p=.015; (CI95% .941-.993). There was no significant association between other factors and the risk for re-intervention. All p-values are > 0.05.

**Table 2** Prognostic factors for re-intervention

| | Re-intervention | | | |
|---|---|---|---|---|
| | *OR* | *P* | *CI 95%* | |
| Age* | .967 | .015 | .941 | .993 |
| Gender[1]<br>Female<br>Male | .800 | .506 | .415 | 1.544 |
| BMI* | .971 | .331 | .915 | 1.030 |
| History of Inflammatory bowel disease<br>No<br>Yes, UC | 2.294 | .560 | .141 | 37.397 |
| History of CVD<br>No<br>Yes | .820 | .646 | .351 | 1.912 |
| History of CVA<br>No<br>Yes | na | na | na | na |
| History of pulmonary disease<br>No<br>Yes | .992 | .986 | .382 | 2.577 |
| History of hypertension<br>No<br>Yes | .820 | .554 | .426 | 1.580 |
| History of diabetes mellitus<br>No<br>Yes | .836 | .592 | .435 | 1.607 |
| History of liver disease | 2.354 | .239 | .565 | 9.802 |

| | | | | |
|---|---|---|---|---|
| No<br>Yes | | | | |
| History of renal impairment<br>No<br>Yes | .661 | .543 | .174 | 2.509 |
| History of other malignancy<br>No<br>Yes | 1.146 | .831 | .329 | 3.988 |
| Pre ED diagnosed patients<br>No<br>Yes | .714 | .353 | .351 | 1.454 |
| ED first diagnosis of CRC at time of complications<br>No<br>Yes | .882 | .724 | .441 | 1.767 |
| Type of surgical procedure[2]<br>Laparotomy<br>Laparoscopy | 1.790 | .086 | .287 | 1.087 |
| Treatment<br>No<br>Yes | .741 | .487 | .319 | 1.722 |
| Tumor Location[3] | 0[a] | . | . | . |
| Ascending | 4.687 | .180 | .489 | 44.904 |
| Descending | .882 | .932 | .051 | 15.368 |
| Transverse | 1.389 | .772 | .151 | 12.813 |
| Sigmoid | 3.529 | .282 | .354 | 35.156 |
| Rectum<br>Cecum | 2.143 | .552 | .174 | 26.329 |
| Type of surgeon[4]<br>Colorectal surgeon<br>General surgeon | 1.261 | .608 | .520 | 3.053 |

*Treated as continuous scale variables; P < 0.05

1) Female as a reference group, 2) Laparotomy as a reference group, 3) Ascending as a reference group,

4) Colorectal surgeon as a reference group,

Values shown as "na" are due to 0 number of cases in the outcome.

Table 3 shows that some of the covariates were significantly associated with experiencing post-operative complications and the final outcome. In the univariate analysis, hospitalization duration and undergoing re-intervention were the most significant factors associated with post-operative complications p=0.002, followed by post-op destination p=0.003 and type of surgery 0.004. After adjustment for age, gender and other significant factors, re-intervention was an independent risk factor for experiencing post-op complications, OR= 3.631 p= 0.002; (CI95% 1.575-8.368). In addition, those who were transported to ICU after surgery were at greater odds of having post-operative complications compared to those admitted in surgical ward OR= 2.799 p= .022; (CI95% 1.162-6.742). Those who underwent laparotomy had almost 3 times higher risk of post-op complications compared to those who underwent a laparoscopic approach, OR= 2.801, p=.018; (CI95% 1.195-6.568). Moreover, those who were presented with perforated colon cancer had around 3 times higher risk of experiencing post-op complications compared to those with obstructing colon cancer. OR=2.720 p= .026; (CI95% 1.128-6.560).

No significant differences were found between other types of cancer complications and post-op complications when compared to the reference category, p>0.05. Furthermore, an increase in hospitalization days was significantly associated with post-operative complications. OR= 1.044 p= .020; (CI95% 1.007-1.082). However, regarding the final outcome, only the variable re-intervention was

significant. After adjustment for other covariates, those who underwent a re-intervention were almost 4 times at higher risk of death compared to those who didn't, OR= 3.929 p= .004; (CI95% 1.533-10.069).

**Table 3** Factors associated with experiencing post-operative complications and the final outcome

| Univariate: | Post-op Complications | | | | Final Outcome | | | |
|---|---|---|---|---|---|---|---|---|
| | *OR* | *P* | | *CI 95%* | *OR* | *P* | | *CI 95%* |
| Pre ED diagnosed patients<br>No<br>Yes | 1.018 | .960 | .508 | 2.040 | 1.640 | .292 | .654 | 4.115 |
| ED first diagnosis of CRC at time of complications<br>No<br>Yes | .805 | .539 | .404 | 1.606 | .462 | .098 | .185 | 1.152 |
| Treatment<br>No<br>Yes | 1.712 | .175 | .787 | 3.724 | 2.236 | .104 | .848 | 5.892 |
| Tumor Location[1] | .907 | .429 | .713 | 1.154 | 1.017 | .922 | .721 | 1.435 |
| Ascending | 0[a] | . | . | . | . | . | . | . |
| Descending | .791 | .729 | .211 | 2.972 | 4.687 | .180 | .489 | 44.904 |
| Transverse | .276 | .112 | .056 | 1.352 | .882 | .932 | .051 | 15.368 |
| Sigmoid | .520 | .260 | .167 | 1.623 | 1.389 | .772 | .151 | 12.813 |
| Rectum | .402 | .205 | .098 | 1.643 | 3.529 | .282 | .354 | 35.156 |
| Cecum | .771 | .719 | .188 | 3.173 | 2.143 | .552 | .174 | 26.329 |
| Type of complication at presentation[2] | | | | | | | | |
| Obstructing colon cancer | 0[a] | . | . | . | 0[a] | . | . | . |
| Perforated colon cancer | 2.720 | .026 | 1.128 | 6.560 | 2.174 | .192 | .678 | 6.971 |
| Obstructing rectal cancer | 1.275 | .734 | .314 | 5.169 | 2.222 | .347 | .421 | 11.739 |
| Perforated rectal cancer | 2.267 | .232 | .593 | 8.669 | 4.286 | .057 | .956 | 19.219 |
| Duration between presentation and surgery | 1.001 | .693 | .997 | 1.004 | 1.000 | .827 | .996 | 1.005 |
| Post-op destination[3]<br>Surgical Ward<br>ICU | 3.061 | .003 | 1.477 | 6.345 | 1.459 | .450 | .547 | 3.893 |
| Type of surgical procedure[4]<br>Laparotomy<br>Laparoscopy | 3.008 | .004 | 1.430 | 6.327 | 1.459 | .443 | .556 | 3.827 |
| Type of surgeon<br>Colorectal surgeon<br>General surgeon | .661 | .408 | .248 | 1.761 | .539 | .427 | .118 | 2.470 |
| Hospitalization duration | 1.054 | .002 | 1.020 | 1.089 | .811 | .995 | .953 | 1.038 |
| Re-intervention<br>No<br>Yes | 4.255 | .002 | 1.682 | 10.765 | 3.600 | .005 | 1.461 | 8.873 |
| Multivariate: | | | | | | | | |
| Age* | .282 | .983 | .952 | 1.014 | 1.018 | .378 | .979 | 1.059 |
| Gender[5]<br>Male<br>Female | 1.686 | .191 | .770 | 3.690 | .643 | .341 | .259 | 1.596 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Post-op destination<br>Surgical Ward<br>ICU | 2.799 | .022 | 1.162 | 6.742 | - | - | - | - |
| Type of surgical procedure[4]<br>Laparotomy<br>Laparoscopy | 2.801 | .018 | 1.195 | 6.568 | - | - | - | - |
| Hospitalization duration | 1.044 | .020 | 1.007 | 1.082 | - | - | - | - |
| Re-intervention<br>No<br>Yes | 3.631 | .002 | 1.575 | 8.368 | 3.929 | .004 | 1.533 | 10.069 |

Treated as continuous scale variables; $P< 0.05$

[1]Ascending as a reference group, [2]Obstructing colon cancer as a reference group, [3]surgical ward as a reference

[4]Laparoscopy as reference, [5]females as a reference group; $P< 0.05$

Table 4 shows the risk factors for different post-operative complications. Patients with history of other malignancy had over 7 times greater risk of experiencing bleeding and sepsis as a post-operative complication compared to those who don't, OR=7.6 and OR= 7.1 p=.028 and 9=.011. No significant associations were observed between age, gender and other comorbidities with all types of post-op complications, p-values > 0.05.

**Table 4** Summary table of types of post-op complications and associated risk factors

| | Type of post-op complication | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Bleeding | | Cardiopulmonary | | Venous thromboembolic event | | Sepsis | | Other | |
| | *OR* | *P* | *OR* | *P* | *OR* | *P* | *OR* | *P* | *OR* | *P* |
| Age* | .986 | .667 | 1.029 | .280 | 1.040 | .283 | .960 | .120 | 1.005 | .921 |
| Gender [1]<br>Female<br>Male | .742 | .720 | 3.621 | .107 | .742 | .720 | .736 | .639 | 1.511 | .738 |
| BMI* | .985 | .841 | 1.020 | .717 | .944 | .459 | .994 | .915 | 1.061 | .552 |
| History of Inflammatory bowel Disease<br>No<br>Yes, UC | na | na | na | na | na | na | na | na | na | na |
| History of CVD<br>No<br>Yes | 4.586 | .07 | 1.655 | .476 | na | na | .455 | .463 | na | na |
| History of CVA<br>No<br>Yes | na | na | na | na | 5.200 | .159 | 2.815 | .361 | na | na |
| History of pulmonary disease<br>No<br>Yes | 1.273 | .829 | 2.569 | .189 | na | na | .687 | .728 | na | na |
| History of hypertension<br>No<br>Yes | 2.320 | .339 | 1.381 | .606 | .552 | .500 | 1.135 | .846 | .558 | .636 |
| History of diabetes mellitus | .929 | .929 | .509 | .297 | .929 | .929 | 4.000 | .086 | .459 | .529 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| No<br>Yes | | | | | | | | | | |
| History of liver disease<br>No<br>Yes | na | na | 2.129 | .499 | na | na | na | na | na | na |
| History of renal impairment<br>No<br>Yes | na | na | 2.949 | .199 | na | na | na | na | 6.375 | .142 |
| History of other malignancy<br>No<br>Yes | 7.600 | .028 | na | na | na | na | 7.095 | .011 | na | na |
| *Treated as continuous scale variables; P < 0.05.<br>[1]females as a reference group; Values shown as "na" is due to 0 numbers of cases in the outcome. | | | | | | | | | | |

In a univariate general linear model (Table 5), age, comorbidities (elevated BMI, CVD, CVA, pulmonary heart disease, hypertension, diabetes mellitus, liver disease, and renal impairment) did not differ significantly in hospitalization duration. However, females had an increased hospitalization stay by average of 4.4 days compared to males p=0.011. Furthermore, patients with a history of UC inflammatory bowel disease and other malignancy had a significant increase in hospitalization duration by 22.8 days p=0.004 and 9 days p=0.007. Also in (Table 5), in the multivariate analysis, post-op destination, having a history of inflammatory bowel disease and the duration between presentation and surgery were independent risk factors for increased hospitalization duration. OR=5.202 p=.009; (CI95% 1.299-9.106) OR=19.823 p= .005; (CI95% 6.258-33.389) and OR=.022 p=.003; (CI95% .008-.037). Gender, having a history of other malignancy, type of surgical procedure and post-op complications were not significant after the adjustment of potential confounder's p> 0.05.

**Table 5** Factors associated with hospitalization length

| Univariate: | Hospitalization Duration | | | |
|---|---|---|---|---|
| | *B* | *p* | *CI 95%* | |
| Age* | .081 | .249 | -.057 | .218 |
| Gender[1]<br>Male<br>female | 4.423 | .011 | 1.008 | 7.839 |
| BMI* | .421 | .437 | .663 | -1.483 |
| History of Inflammatory bowel disease<br>No<br>Yes, UC | 22.766 | .004 | 7.230 | 38.303 |
| History of CVD<br>No<br>Yes | 3.641 | .093 | -.617 | 7.9000 |
| History of CVA<br>No<br>Yes | .966 | .826 | -7.674 | 9.605 |
| History of pulmonary heart disease<br>No<br>Yes | 2.639 | .299 | -2.366 | 7.644 |

| | | | | |
|---|---|---|---|---|
| History of Hypertension<br>No<br>Yes | -1.498 | .391 | -4.936 | 1.939 |
| History of Diabetes mellitus<br>No<br>Yes | .716 | .682 | -2.726 | 4.158 |
| History of Liver disease<br>No<br>Yes | 1.025 | .804 | -7.105 | 9.155 |
| History of Renal impairment<br>No<br>Yes | 3.705 | .257 | -2.731 | 10.142 |
| History of other malignancy<br>No<br>Yes | 9.057 | .007 | 2.498 | 15.616 |
| Post-op complication<br>No<br>Yes | 6.840 | .000 | 3.187 | 10.493 |
| Type of surgical procedure[2]<br>Laparotomy<br>Laparoscopy | 4.200 | .018 | .728 | 7.672 |
| Duration between presentation and surgery (Hours) | .022 | .004 | .007 | .038 |
| Post-op destination[3]<br>Surgical Ward<br>ICU | 6.231 | .002 | 2.397 | 10.066 |
| Pre emergency department diagnosis of CRC<br>No<br>Yes | 2.036 | .267 | -1.577 | 5.649 |
| Treatment<br>No<br>Yes | 2.856 | .188 | -1.408 | 7.120 |
| Tumor location[4]<br>Ascending | 2.625 | .525 | -5.508 | 10.758 |
| Descending | 5.536 | .154 | -2.098 | 13.169 |
| Transverse | 1.306 | .745 | -6.598 | 9.209 |
| Sigmoid | 3.233 | .326 | -3.251 | 9.717 |
| Rectum | 4.869 | .209 | -2.765 | 12.503 |
| Cecum | 0[a] | . | . | . |
| Type of surgeon[5]<br>Colorectal surgeon<br>General surgeon | -1.613 | .506 | -6.392 | 3.166 |
| Multivariate: | | | | |
| Age | .028 | .674 | -.102 | .158 |

| | | | | |
|---|---|---|---|---|
| Gender<br>Male<br>Female | -1.444 | .375 | -4.656 | 1.768 |
| History of other malignancy<br>No<br>Yes | -.134 | .966 | -6.346 | 6.078 |
| Type of surgical procedure<br>Laparotomy<br>Laparoscopy | -.774 | .652 | -4.163 | 2.615 |
| Post-op destination<br>Surgical Ward<br>ICU | 5.202 | .009 | 1.299 | 9.106 |
| History of inflammatory bowel disease<br>No<br>Yes | 19.823 | .005 | 6.258 | 33.389 |
| Post-op complication<br>No<br>Yes | 3.499 | .066 | -.229 | 7.227 |
| Duration between presentation and surgery (Hours) | .022 | .003 | .008 | .037 |

*Treated as continuous scale variables; $P < 0.05$

[1]Males as a reference group; [2]Laparoscopy as reference group; [3]Surgical ward as a reference group; [4]Cecum as a reference group; [5]Colerectal surgeon as a reference group

## 4. DISCUSSION

Emergency management of complicated colonic cancer depends on many factors including tumor location and stage, overall condition of the patient and surgeon's experience. Obstruction was found to be the most commonly reported complication of colon cancer in our study. Similarly, other studies cited obstruction to be more frequent than perforation (Biondo et al., 2008; Enciu et al., 2019). Several studies demonstrated the survival and outcomes among patients with complicated colon cancer. Chen et al., (2000) revealed that neoplastic bowel obstruction, but not bowel perforation at the tumor site, was associated with poor survival.

Banaszkiewicz et al., (2014) demonstrated an increased rate of complications and mortality in these patient groups. Ho et al., (2010) study found that bowel obstruction and bowel perforation were significantly correlated with poor disease survival in patients with colorectal cancer. The reported postoperative mortality rate was 1.5%, and complications rate was 40% among 1876 patients who underwent emergency surgery for obstructing or perforated colon cancer. In a study conducted in France, the mortality rate was reported to be 8.7% among patients undergoing emergent surgery for malignant colon obstruction (Collard et al., 2018). In contrast, our study showed a higher mortality rate (13.5%), and around 30% developed complications post-operatively. Several factors were significantly associated with experiencing postoperative complications such as colonic perforation, laparotomy approach, and undergoing another surgical intervention. The outcomes of patients undergoing surgical interventions for complicated colon cancer are influenced by several surgeon-dependent factors (McArdle et al., 2004; Biondo et al., 2010). In one study compared those operated on by a colorectal surgeon (CRS) and those operated on by a general surgeon (GS). Postoperative morbidity rate was 52% in the CRS group and 60.5% in the GS group ($P = .01$), and those who were operated by CRS had a lower mortality rate compared to the GS group (Biondo et al., 2010).

In our study most of the patients were operated on by CRS; however, there was no statistical significance in terms of postoperative complications and outcome between the two groups. Thus, it is likely that increased specialization rather than the specialty itself will lead to further improvements in the overall prognosis and survival rates. Undergoing another surgical intervention at the same admission after initial surgical management of complicated colon cancer was observed in 30.6% of our patients. The most reported reason for undergoing re-intervention was for curative purposes in 42.3%, this was followed by recurrence of complication (obstruction or perforation) in 38.5%, and management of surgical complications in 19.2%. Undergoing another re-intervention was observed to be significantly associated with experiencing post-operative complications.

Previous studies demonstrated the rate of reoperation and in-hospital mortality to be 12.8% and 2.4% respectively among patients undergoing elective colon cancer surgeries (van Westreenen et al., 2011). Data regarding reoperation rates in elective colorectal surgery varies and most studies have reported the incidence of surgical re-intervention to be between 5-7% (Morris et al., 2007; Merkow et al., 2009). Marek Zawadzki (2019) demonstrated that reoperations after curative colorectal cancer surgery are more frequent and might occur in over a tenth of total patients underwent an operative surgery. However, there is limited number of studies that evaluated the rate of re-intervention among patients with bowel obstruction or perforation secondary to colon cancer. One reason is the lack of a clear definition of "reoperation" after initial surgical management. In addition, there are no definitive guidelines describing a clear indications or timing of return to the operating theatre. More commonly, the management of postoperative complications is at the discretion of the surgeon concerned and it may vary among different institutions or individual surgeons. One may ask if surgical re-intervention for complicated colon cancer might be of a benefit for some patients in terms of curative purposes.

The current published data cannot answer this question. Biondo et al., (2005) suggested that curative surgeries for complicated colonic cancer patinets are acceptable in emergency conditions if a surgical treatment with radical oncologic criteria is performed. Colorectal cancer is the commonest cancer in Saudi Arabia among men and the third most prevalent cancer among women. In 2020, a study indicated an increase in crude incidence rates and age-standardized incidence rates of colorectal cancer in the population of Saudi Arabia (Almatroudi, 2020). The percentage of colorectal cancer cases of all diagnosed cancers increased two-fold from 4.8% to 10.1% over the period of 1994–2010 (Al-Eid, 2014). Previous studies demonstrated a rate of 15% - 30% CRC diagnosis presenting as an emergency (Waldron et al., 1986).

In the current study, more than half of the patients presenting with bowel obstruction or perforation had no previous diagnosis of CRC. One strategy that might help in decreasing CRC complications rates is early detection and screening. The Saudi Ministry of Health recommends offering colorectal cancer screening to asymptomatic, average-risk persons at the age 50 years (Aljumah & Aljebreen, 2017). These observations not only reinforce physicians practicing at primary health cares to have more education/orientation about the magnitude of the problem we face with CRC, but also the impact of screening might have on reducing this threat.

## 5. CONCLUSION

Due to the lack of the general understanding of CRC screening in Saudi Arabia, a large proportion of our patients diagnosed with colon cancer at the time of complication. The most common presenting emergency is colonic obstruction. Rate of re-intervention after initial surgical management appears to be relatively high and associated with increased mortality among patients with complicated colon cancer. Further studies are needed to determine the appropriate timing and indications for undergoing a surgical intervention after initial surgical management of complicated colon cancer.

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**Author Contributions**

All authors made substantial contributions to the design of the study, data collection process, data analysis and writing of the manuscript. All authors read and approved the final manuscript and gave final approval of the version to be published.

**Ethical approval**

The study was approved by the Medical Ethics Committee of King Abdullah International Medical Research Center (ethical approval code: RC 20/518/R).

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**Conflict of Interest**

The authors declare that there are no conflicts of interests.

**Data and materials availability**

All data associated with this study are presented in the paper.

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